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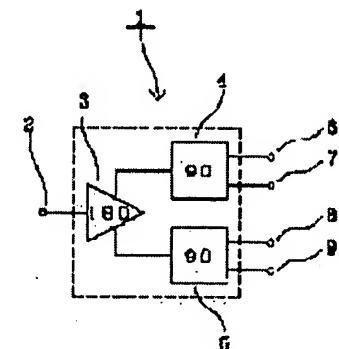
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## (54) FOUR-PHASE CONVERTER AND ORTHOGONAL MODULATOR USING THE SAME

## (57)Abstract:

PROBLEM TO BE SOLVED: To provide the four-phase converter at low cost, without distortion by harmonics with low power consumption.

SOLUTION: A 180° phase shifter 3 which is the component of the four-phase converter 1 is formed by a 180° balun being three coupled microstrip lines, 90° phase shifters 4, 5 connected to two outputs of the 180° phase shifter 3 are formed respectively by a 90° coupler being two coupled microstrip lines, and the 180° phase shifter 3 and the 90° phase shifters 4, 5 are formed on a high dielectric constant dielectric board. Thus, the power consumption is smaller than that of the case with employment of active components formed in an IC, the problem of harmonics due to a nonlinear characteristic of the active components is avoided and the cost is considerably reduced. Deviation or dispersion in phases due to connection wiring of the respective phase shifters is reduced by forming them on one dielectric board and a stable characteristic is obtained. Moreover, miniaturization is attained by forming the phase shifters on the dielectric board with a high dielectric constant.



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DETAILED DESCRIPTION

## Detailed Description of the Invention]

0001]

Field of the Invention] This invention relates to the quadrature modulation machine which used 4 phase phase converter and this especially 4 phase phase converter used for a QPSK modulation, and the quadrature modulation machine using this.

0002]

Description of the Prior Art] The example of the quadrature modulation machine used for a QPSK modulation constituted as one IC by drawing 8 is shown. In drawing 8, the quadrature modulation machine 100 consists of the local signal input terminal 101, the 90-degree phase shifter 102 by the flip-flop circuit, the 180-degree phase shifters 103 and 104 by the differential amplifying circuit, the I signal input terminal 105, the Q signal input terminal 106, mixer circuits 107 and 108 of a double balance mold, a subtraction machine 109, and a modulating-signal output terminal 110.

0003] In the quadrature modulation machine 100, the local signal input terminal 101 is connected to a phase shifter 102 90 degrees, and the two outputs are connected to phase shifters 103 and 104 180 degrees, respectively. And two outputs of two each of the 180-degree phase shifters 103 and 104 are inputted into mixer circuits 107 and 108, respectively. On the other hand, the I signal input terminal 105 and the Q signal input terminal 106 are also connected to mixer circuits 107 and 108, respectively. The output of two each of mixer circuits 107 and 108 connects one at a time respectively, is summarized to two and connected to the modulating-signal output terminal 110 through the subtraction machine 109.

0004] Among these, the 90-degree phase shifter 102 and the 180-degree phase shifters 103 and 104 function as a 4 phase phase converter in the condition of having been collected. Moreover, the quadrature modulation machine 100 is constituted as IC112 as a whole.

0005] Thus, in the constituted quadrature modulation machine 100, the local signal inputted from the local signal input terminal 101 is divided into the local signal which is two from which the phase shifted 90 degrees mutually with the phase shifter 102 90 degrees, and is divided into the signal with which it is phase shifters 103 and 104, and the phase shifted 180 degrees still respectively more nearly 180 degrees further, respectively. Consequently, the local signal which is four from which the phase shifted about 90 degrees mutually, respectively is generated. Four local signal are divided into two groups which packed the signal which is two from which the phase shifted 180 degrees mutually, and are inputted into mixer circuits 107 and 108, respectively. In mixer circuits 107 and 108, a modulation is applied to each local signal by the data inputted from the I signal input terminal 105 and the Q signal input terminal 106, and it is outputted to the modulating-signal output terminal 110 via the subtraction machine 109.

0006]

Problem(s) to be Solved by the Invention] With the above-mentioned quadrature modulation vessel, since it builds in C, the 180-degree phase shifters 103 and 104 by the 90-degree phase shifter 102 and differential amplifying circuit by the flip-flop circuit are used for the part which functions as a 4 phase phase converter. In this case, the higher harmonic occurred to the signal outputted by the nonlinear characteristic which needs power since each uses the active element, and an active element has, and it had become the cause which distortion produces in the output of the quadrature modulation machine 100.

0007] Moreover, when it builds the 180-degree phase shifter by the 90-degree phase shifter and differential amplifying circuit by the flip-flop circuit in IC, it is necessary to build in an inductor and a capacitor in IC chip, and this also has the problem that the cost of IC becomes high in order to increase the chip area of IC substantially.

0008] Furthermore, although there is also the approach of adopting CR phase shifter using the capacitor and resistance which are a passive element as a phase shifter 90 degrees and power is not needed in this case, there is a problem that the precision of a phase is bad.

0009] This invention is for solving the above-mentioned trouble, and offers 4 phase phase converter with little listortion, and the quadrature modulation machine using this by low loss.

0010]

Means for Solving the Problem] In order to attain the above-mentioned object, 4 phase phase converter of this invention is characterized by forming in the top face of a dielectric substrate the phase shifter which has one input and one or more outputs which were made to combine two or more quarter-wave length microstrip lines, and were constituted at one or more two one.

0011] Moreover, the 180-degree phase shifter constituted as a 180-degree balun which 4 phase phase converter of this invention makes combine three quarter-wave length microstrip lines, and has one input and two outputs, Two quarter-wave length microstrip lines are combined, and it consists of a 90-degree phase shifter constituted as a 90-degree coupler which has one input and two outputs, and is characterized by connecting said two 90-degree phase shifters to two outputs of a phase shifter said 180 degrees, respectively.

0012] Moreover, the 90-degree phase shifter constituted as a 90-degree coupler which 4 phase phase converter of this invention makes combine two quarter-wave length microstrip lines, and has one input and two outputs, Three quarter-wave length microstrip lines are combined, and it consists of a 180-degree phase shifter constituted as a 180-degree balun which has one input and two outputs, and is characterized by connecting said two 180-degree phase shifters to two outputs of a phase shifter said 90 degrees, respectively.

0013] Moreover, the quadrature modulation machine of this invention is characterized by consisting of an above-mentioned 4 phase phase converter and an IC including at least two mixer circuits.

0014]

Embodiment of the Invention] One example of 4 phase phase converter of this invention is shown in drawing 1. In drawing 1, 4 phase converter 1 consists of 90-degree phase shifters 4 and 5 connected to two outputs of the 3, 180-degree-shifters phase shifter 3 180 degrees connected to the input terminal 2 and the input terminal 2, respectively, and output terminals 6, 7, 8, and 9 of the 90-degree phase shifters 4 and 5 connected to two outputs, respectively.

0015] The detail of each component of 4 phase phase converter shown in drawing 2 at drawing 1 is shown. By drawing 2, the same notation is given to the same part as the example of drawing 1, and the explanation is omitted.

0016] In drawing 2, the 180-degree phase shifter 3 combines mutually three quarter-wave length microstrip lines 3a, 3b, and 3c, and is constituted as a 180-degree balun which has one input and two outputs. Although the configuration of a balun is known from the former 180 degrees and detailed explanation is omitted, by this, a phase can change one signal inputted from the end of microstrip line 3a into the signal which is two [ different 180 degrees ], and can output it from the other end of microstrip lines 3a and 3c.

0017] Moreover, the 90-degree phase shifters 4 and 5 combine two quarter-wave length microstrip lines 4a and 4b, and 5a and 5b, and are constituted as a 90-degree coupler which has one input and two outputs, respectively. Although the configuration of a coupler is also known from the former 90 degrees and detailed explanation is omitted, by this, mutually, a phase can change one signal inputted from the end of microstrip lines 4a and 5a into the signal which is two different 90 degrees ], and can output it from the other end of microstrip line 4a, the end of microstrip line 4b, and the other end of microstrip line 5a and the end of microstrip line 5b, respectively. In addition, 4c and 5c are resistance for termination.

0018] And it connects, respectively and one 180-degree phase shifter 3 and two 90-degree phase shifters 4 and 5 are formed for the other end of microstrip line 3a, the end of microstrip line 4a, and the other end of microstrip line 3c and the end of microstrip line 5a on one dielectric substrate at one.

0019] The example in which 4 phase phase converter 1 shown in drawing 3 at drawing 1 and drawing 2 was formed on the dielectric substrate of a high dielectric constant is shown. Here, the same notation is given to the same part as drawing 1 and drawing 2. In drawing 3, the microstrip line which constitutes a phase shifter 3 and the 90-degree phase shifters 4 and 5 180 degrees is formed the shape of MIANDA, and in the shape of a spiral, in order to make area small. In addition, connection with other circuits of an input terminal 2 and output terminals 6, 7, 8, and 9 is made by wire bonding. Thus, a phase shifter 3 and the 90-degree phase shifters 4 and 5 are formed 180 degrees on one dielectric substrate at one, and 4 phase phase converter 1 is constituted.

0020] The signal inputted into drawing 1 from the input terminal 2 in return and 4 phase phase converter 1 constituted in this way. It is divided into the signal which is two from which the phase shifted 180 degrees mutually with the phase shifter 3 180 degrees, and further, the two signals are divided into the signal which is two from which the phase shifted 90 degrees mutually with phase shifters 4 and 5 90 degrees, respectively, and are divided into the signal which is four from which the phase shifted 90 degrees mutually as a result.

0021] As mentioned above, by forming 4 phase phase converter only using a passive element called an electrode pattern.

ind resistance, compared with the case where an active element is used like a flip-flop circuit or the differential amplifier, power consumption becomes small and the problem of generating of the higher harmonic by the nonlinear characteristic of an active element is also lost. Moreover, as compared with the case where it forms on IC, cost can be substantially made small by forming 4 phase phase converter on a dielectric substrate. Moreover, by forming on one dielectric substrate, there are little each phase shift and dispersion by connection wiring of a phase shifter, and the stable property can be acquired. Furthermore, a miniaturization can also be attained by forming on the dielectric substrate of a high dielectric constant. In addition, in the example shown in drawing 3 which the invention-in-this-application person created, when specific inductive capacity used the dielectric substrate of the high dielectric constant of 110, the size of 4 phase phase converter became about 2mm angle, and has realized the large miniaturization.

0022] Another example of 4 phase phase converter of this invention is shown in drawing 4. In drawing 4, 4 phase phase converter 21 consists of 180-degree phase shifters 24 and 25 connected to two outputs of the 23 or 90 phase-shifters phase shifter 23 90 degrees connected to the input terminal 22 and the input terminal 22, respectively, and output terminals 26, 27, 28, and 29 of the 180-degree phase shifters 24 and 25 connected to two outputs, respectively.

0023] The detail of each component of 4 phase phase converter shown in drawing 5 at drawing 4 is shown. By drawing 5, the same notation is given to the same part as the example of drawing 4, and the explanation is omitted.

0024] In drawing 5, the 90-degree phase shifter 23 combines mutually two quarter-wave length microstrip lines 23a and 23b, and is constituted as a 90-degree coupler which has one input and two outputs. Although the configuration of a coupler is known from the former 90 degrees and detailed explanation is omitted, by this, a phase can change one signal inputted from the end of microstrip line 23a into the signal which is two [ different 90 degrees ], and can output it from the other end of microstrip line 23a, and the end of microstrip line 23b. In addition, 23c is resistance for termination.

0025] Moreover, the 180-degree phase shifters 24 and 25 combine 25b and 25c with three quarter-wave length microstrip lines 24a and 24b, and 24c and 25a, and are constituted as a 180-degree coupler which has one input and two outputs, respectively. Although the configuration of a coupler is also known from the former 180 degrees and detailed explanation is omitted, by this, mutually, a phase can change one signal inputted from the end of microstrip lines 24a and 25a into the signal which is two [ different 180 degrees ], and can output it from microstrip lines 24a and 24c and the other end of 25a and 25c, respectively.

0026] And it connects, respectively and one 90-degree phase shifter 23 and two 180-degree phase shifters 24 and 25 are formed for the other end of microstrip line 23a, the end of microstrip line 24a, and the end of microstrip line 23b and the end of microstrip line 25a on one dielectric substrate (not shown) at one.

0027] The signal inputted into drawing 4 from the input terminal 22 in return and 4 phase phase converter 21 constituted in this way. It is divided into the signal which is two from which the phase shifted 90 degrees mutually with the phase shifter 23 90 degrees, and further, the two signals are divided into the signal which is two from which the phase shifted 180 degrees mutually with phase shifters 24 and 25 180 degrees, respectively, and are divided into the signal which is four from which the phase shifted 90 degrees mutually as a result.

0028] In the example shown in drawing 4, the difference from the example shown in drawing 1 is only the configuration of the phase shifter inside 4 phase phase converter, the actuation and effectiveness as a 4 phase phase converter are the same as the example shown in drawing 1, and the explanation is omitted.

0029] In addition, in the example shown in above-mentioned drawing 1 and above-mentioned drawing 4, although 4 phase phase converter was constituted from one combination of a 180-degree phase shifter, two 90-degree phase shifters or one a 90-degree phase shifter and two 180-degree phase shifters. Two or more are combined, and the phase shifter constituted combining two or more quarter-wave length microstrip lines will not be restricted to what was shown in the example of drawing 1 and drawing 4, if it is one or the thing to constitute.

0030] One example of the quadrature modulation machine of this invention is shown in drawing 6. In drawing 6, the quadrature modulation machine 40 consists of output terminals 47 connected to the output of IC48 for a modulation connected to 4 phase phase converter 1 and 4 phase phase converter 1 which were connected to the local signal input terminal 41 and the local signal input terminal 41, and IC48 for a modulation. Here, 4 phase phase converter 1 is the same as that of what was shown in drawing 1, and omits explanation. Moreover, IC48 for a modulation consists of an I signal input terminal 42 connected to the mixer circuits 44 and 45 of two double balance molds connected to four output of 4 phase phase transducer 1, and a mixer circuit 44, a Q signal input terminal 43 connected to a mixer circuit 45, and a subtraction machine 46 connected to mixer circuits 44 and 45.

0031] Thus, in the constituted quadrature modulation machine 40, the local signal inputted from the local signal input terminal 41 is 4 phase phase converter 1, is divided into the group of the signal which is two from which was changed and outputted to the local signal which is four from which the phase shifted 90 degrees mutually, among those the phase shifted 180 degrees mutually, and is inputted into mixer circuits 44 and 45. In mixer circuits 44 and 45, a modulation is

applied to each local signal with the I signal and Q signal which were inputted from the I signal input terminal 42 and the Q signal input terminal 43, and a modulating signal is outputted to the modulating-signal output terminal 47 via the subtraction machine 46.

0032] As mentioned above, by forming the part of 4 phase phase converter on the dielectric substrate of a high dielectric constant, and constituting the quadrature modulation machine 40 combining IC48 for a modulation including two mixer circuits 44 and 45, the area in which 4 phase phase converter occupied all the quadrature modulation machines in IC compared with the case where it constitutes from an IC can be reduced, and cost of IC can be made low. Moreover, by making 4 phase phase converter from a passive element, only the part to which power consumption becomes small can realize low electrification of a quadrature modulation machine, and that also of the problem [ modulating signal / by the higher harmonic added to a local signal by the nonlinear characteristic of the active element used for 4 phase phase converter ] of distortion is lost further.

0033] Another example of the quadrature modulation machine of this invention is shown in drawing 7. In drawing 7, the notation same about the same part as the example of drawing 6 is attached, and explanation is omitted. In drawing 7, the quadrature modulation machine 50 consists of output terminals 47 connected to the output of IC48 for a modulation connected to 4 phase phase converter 21 and 4 phase phase converter 21 which were connected to the local signal input terminal 41 and the local signal input terminal 41, and IC48 for a modulation. Here, 4 phase phase converter 21 is the same as that of what was shown in drawing 4, and omits the explanation.

0034] In the example shown in drawing 7, the difference from the example shown in drawing 6 is only a difference in the internal configuration of 4 phase phase converter, the actuation and effectiveness as the quadrature modulation machine are completely the same as the example shown in drawing 6, and the explanation is omitted.

0035]

Effect of the Invention] According to the 4 phase phase converter of this invention, the phase shifter which was made to combine two or more quarter-wave length microstrip lines, and was constituted One or two or more, for example, a 180-degree phase shifter, by combining two or a 90-degree phase shifter with one for a phase shifter 90 degrees, combining two with one for a phase shifter 180 degrees, and forming and constituting on a dielectric substrate at one. Compared with the case where an active element is used, power consumption becomes small and the problem of the higher harmonic by the nonlinear characteristic of an active element is also lost. Moreover, as compared with the case where it forms on IC, cost can be substantially made low. Moreover, by forming on one dielectric substrate, there are little each phase shift and dispersion by connection wiring of a phase shifter, and they become the stable thing. Furthermore, a miniaturization can also be attained by forming on the dielectric substrate of a high dielectric constant.

0036] Moreover, according to the quadrature modulation machine of this invention, by forming 4 phase phase converter as mentioned above, and constituting this combining IC including at least two mixer circuits, the area which 4 phase phase converter occupied in IC can be reduced, and cost of IC can be made low. Moreover, only the part to which power consumption becomes small can realize low electrification of a quadrature modulation machine, and the higher harmonic also of the problem [ modulating signal / used as a cause ] of distortion of the local signal by the nonlinear characteristic of the active element used for 4 phase phase converter is lost further.

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Translation done.]